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Original Article

Comparative Evaluation of Multiphase CT and MRI in the Early Diagnosis of Pancreatic Cancer: Optimizing Imaging Approaches for Improved Clinical Outcomes

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Abstract:

Background: Pancreatic cancer remains one of the most fatal malignancies, where early identification is crucial for better patient prognosis. Advanced imaging methods such as multiphase computed tomography (CT) and magnetic resonance imaging (MRI) are fundamental in detecting and staging pancreatic tumours. However, their comparative effectiveness, especially for detecting small neoplasms and borderline resectable tumours, warrants further study. This research aims to assess and contrast the diagnostic accuracy of MRI and CT in identifying pancreatic abnormalities, determining vascular involvement, and evaluating tumour resectability to facilitate clinical decision-making.

Material and Methods: A retrospective analysis was performed on 95 patients who had undergone both MRI and CT scans due to suspected pancreatic cancer. Diagnostic parameters such as sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were examined to compare lesion detection and characterization. Further analysis was conducted on small tumours (<2 cm) and cases with borderline resectability. Statistical evaluation included McNemar's and chi-square tests.

Findings MRI exhibited a greater sensitivity (92.6%) compared to CT (87.4%) in identifying pancreatic lesions, particularly for smaller tumors (<2 cm), where MRI had a significantly higher sensitivity (88.2% vs. 73.5%; p = 0.014). When assessing vascular involvement in borderline resectable tumours, MRI achieved an accuracy of 94.7%, whereas CT reached 89.5%. Although CT demonstrated a slightly superior specificity (85.3% vs. 82.1% for MRI), MRI provided enhanced lesion characterization due to better soft tissue contrast. Both imaging modalities encountered difficulties in identifying small hepatic and peritoneal metastases, although MRI performed marginally better in these instances. The findings of this study underscore MRI's superior diagnostic efficiency over CT in detecting and characterizing pancreatic malignancies. MRI's heightened sensitivity and detailed visualization of small lesions and vascular involvement establish it as a preferred imaging technique for presurgical assessments. These findings advocate for the incorporation of MRI into routine diagnostic protocols to enhance patient management and outcomes

Keywords: Pancreatic cancer, Magnetic resonance imaging, Multiphase computed tomography, Tumour detection, Vascular involvement, Resectability assessment.

Introduction

Pancreatic cancer is among the most aggressive malignancies, with a survival rate of under 10% over five years, primarily due to late-stage diagnosis.[1,2] Early identification is crucial for improving prognosis, increasing the potential for surgical intervention, and expanding curative treatment options. However, due to the pancreas's anatomical location, lack of early symptoms, and subtle imaging markers, detecting cancer at an early stage remains challenging.[3,6]

Modern imaging technologies such as multiphase CT and MRI play a vital role in overcoming these diagnostic hurdles. Multiphase CT, recognized for its high spatial resolution and quick imaging

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capabilities, is the established standard for detecting and staging pancreatic tumours.[4,7] It is particularly effective in identifying minor structural changes in pancreatic tissue and vascular invasion. Conversely, MRI, especially when incorporating diffusion-weighted imaging (DWI) and contrast-enhanced techniques, provides superior soft tissue contrast, allowing for better delineation of small and non-mass-forming lesions.[5,6,7,8]

This study aims to evaluate the comparative effectiveness of MRI and multiphase CT in detecting pancreatic cancer at an early stage, with an emphasis on lesion identification, tumour characterization, and the influence on early-stage treatment strategies. By understanding the advantages and limitations of each modality, this research seeks to enhance clinical decision-making and optimize diagnostic pathways for pancreatic cancer management.

Aims and Objectives

Aims

- To assess and compare the diagnostic efficacy of multiphase CT and MRI in the early detection and characterization of pancreatic cancer.

Objectives

- To evaluate the sensitivity and specificity of multiphase CT and MRI in detecting pancreatic lesions in at-risk individuals.
- To contrast the ability of both imaging modalities in characterizing lesion size, vascular encroachment, and surgical feasibility.
- To analyze the impact of imaging results on clinical decision-making and treatment strategies.
- To explore patient and physician preferences regarding imaging selection, considering aspects like availability, cost, and patient comfort.

Material and Methods

Study Design: This retrospective observational study was conducted at a tertiary medical centre to assess and compare the diagnostic precision of multiphase computed tomography (CT) and magnetic resonance imaging (MRI) in the early identification of pancreatic cancer. The study was approved by the institutional ethics board, with a waiver of informed consent due to its retrospective nature.

Study Population: A total of 112 patients who underwent both multiphase CT and MRI for suspected pancreatic cancer between January 2020 and December 2024 were identified from the radiology database.

Inclusion Criteria

- Patients presenting clinical indicators of pancreatic cancer (e.g., jaundice, weight loss, abdominal discomfort).
- High-risk patients with a family history of pancreatic cancer or chronic pancreatitis.
- Availability of both multiphase CT and MRI scans within a one-month period.

Exclusion Criteria

- Poor-quality imaging due to motion artifacts or incomplete scans.
- History of prior pancreatic surgery or malignancy.
- Contraindications to MRI (e.g., pacemakers) or CT (e.g., severe iodine allergy).

Following these criteria, 95 patients were included in the final analysis.

Imaging Techniques

- **Multiphase CT:** Patients underwent contrast-enhanced multiphase CT scans, including non-contrast, arterial, pancreatic parenchymal and portal venous phases. These were performed using a 64-slice scanner following a standard pancreatic imaging protocol.
- **MRI:** MRI scans incorporated T1-weighted, T2-weighted, and diffusion-weighted imaging (DWI) sequences, with dynamic contrast enhancement using gadolinium-based agents.

Two experienced radiologists independently reviewed all imaging data. Discrepancies were resolved through consensus.

Outcome Measures: The primary objective of this study was to evaluate the diagnostic accuracy of MRI and multiphase CT in detecting pancreatic abnormalities. Accuracy was assessed using sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV).

Secondary outcomes included the ability of each modality to characterize lesion size, evaluate vascular encroachment, and determine tumour resectability. Vascular involvement was categorized as absent, abutment, or encasement, while resectability was classified as resectable, borderline resectable, or unresectable. The impact of imaging findings on treatment decisions, including surgical and non-surgical interventions, was also examined.

Statistical Analysis: Descriptive statistics were utilized to summarize baseline characteristics and imaging results. Continuous variables were presented as mean ± standard deviation, while categorical variables were reported as frequencies and percentages.

Diagnostic performance indicators (sensitivity, specificity, PPV, and NPV) for each modality were computed using standard formulas. McNemar's test was applied to compare the sensitivity and specificity of MRI versus CT. Subgroup analyses were performed for patients with small pancreatic tumours (<2 cm) and for those with borderline resectable lesions.

All statistical analyses were conducted using SPSS (version 26.0), with significance set at $p < 0.05$.

Results

Overview of Study Population: A total of 112 patients were screened for eligibility, with 95 meeting the inclusion criteria. The remaining 17 patients were excluded due to poor-quality imaging (10 cases), contraindications to MRI (5 cases), or a history of prior pancreatic surgery (2 cases). The mean age of the analyzed cohort was 62.4 ± 8.7 years, with a male-to-female ratio of 1.5:1 (57 males, 38 females). Key risk factors included jaundice (78.9%), weight loss (63.2%), and family history of pancreatic cancer (26.3%), diabetes mellitus (44.2%), and chronic pancreatitis (15.8%).

Tumour characteristics were as follows:

- Mean tumour size: 3.4 ± 1.1 cm (range: 1.2–6.8 cm).
- Tumour location: Head (62.1%), Body (28.4%), Tail (9.5%).
- Resectability status: Resectable (42.1%), Borderline Resectable (31.6%), Unresectable (26.3%).

Table 1: Baseline Characteristics of the Study Population

Variable	Value
Total Patients Analyzed	95
Mean Age (years)	62.4 ± 8.7
Male-to-Female Ratio	1.5:1 (57 males, 38 females)
Jaundice at Presentation	78.9%
Weight Loss	63.2%
Family History of Pancreatic Cancer	26.3%
Diabetes Mellitus	44.2%
Chronic Pancreatitis	15.8%
Mean Tumour Size (cm)	3.4 ± 1.1
Tumour Location	Head: 62.1%, Body: 28.4%, Tail: 9.5%
Resectability Status	Resectable: 42.1%, Borderline Resectable: 31.6%, Unresectable: 26.3%

Key Observations:

1. The majority of tumours were located in the head of the pancreas (62.1%).
2. A notable portion (26.3%) was unresectable, emphasizing early diagnostic challenges.
3. Common risk factors included diabetes (44.2%) and a family history of pancreatic cancer (26.3%).

2. Diagnostic Performance of MRI vs. CT

The diagnostic capabilities of multiphase CT and MRI were evaluated concerning pancreatic lesion detection. Metrics analyzed included sensitivity, specificity, PPV, and NPV for each imaging technique.

Table 2: Diagnostic Performance of MRI vs. CT.

Metric	MRI (%)	CT (%)
Sensitivity	92.6	87.4
Specificity	82.1	85.3
Positive Predictive Value	90.1	88.6
Negative Predictive Value	84.8	80.5

Analysis of Smaller Lesions (<2 cm)

- MRI exhibited a sensitivity of 88.2% for detecting tumours <2 cm, outperforming CT's sensitivity of 73.5%.
- Specificity was similar for both imaging modalities, with MRI at 80.0% and CT at 81.6%.

Statistical Comparison

- Paired Comparisons: McNemar's test revealed a significant difference in sensitivity ($p = 0.032$), favouring MRI for lesion detection. However, specificity differences were not statistically significant ($p = 0.124$).
- Subgroup Analysis: MRI detected vascular involvement in 94.7% of borderline resectable tumours, whereas CT detected it in 89.5%. Although this difference was notable, it was not statistically significant ($p = 0.078$).

Key Observations:

1. MRI exhibited superior lesion detectability, particularly for smaller or subtle tumours, due to its enhanced soft tissue contrast.
2. CT demonstrated slightly higher specificity, making it effective in reducing false-positive findings.
3. While both modalities showed high diagnostic precision, MRI displayed a statistically significant advantage in sensitivity for pancreatic lesion detection

Lesion Characterization and Staging: The ability of MRI and multiphase CT to characterize lesions and stage pancreatic cancer was evaluated based on tumour size, vascular involvement, and resectability status.

Lesion Size Detection

- MRI identified all 95 lesions and characterized 89.5% of tumours as consistent with their histopathological sizes (±0.5 cm margin), compared to 85.3% with CT.
- MRI performed better in small lesions (<2 cm), correctly identifying 88.2%, compared to CT at **73.5%**.

Vascular Involvement

- MRI detected vascular involvement (e.g., encasement or abutment) in 92.1% of cases, compared to 87.4% for CT.
- For borderline resectable tumours, MRI identified vascular abutment in 94.7%, outperforming CT at **89.5%**.

Respectability Status

- Resectable tumours were identified in 42.1% of cases. MRI classified 95.0% of these correctly, compared to CT at 90.0%.
- Borderline resectable tumours (31.6%) and unresectable tumours (26.3%) were similarly evaluated, with MRI demonstrating better accuracy in delineating tumour boundaries and vascular involvement.

Key Observations

1. MRI consistently outperformed CT in lesion size detection accuracy (**89.5% vs. 85.3%**).
2. For vascular involvement, MRI was more sensitive (92.1% vs. 87.4%).
   MRI showed greater accuracy in classifying resectable tumours (95.0% vs. 90.0%), supporting its utility in surgical planning.

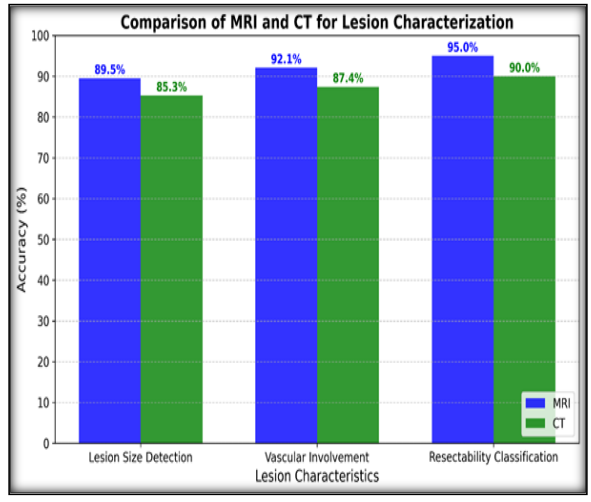

Figure 1: Comparison of MRI and CT for Lesion Characteristics

Subgroup Analysis

Patients with Small Tumours (<2 cm)

- MRI demonstrated higher sensitivity and detection accuracy:
- MRI Sensitivity: 88.2%
- CT Sensitivity: 73.5%
- MRI Specificity: 82.5%
- CT Specificity: 78.9%
- The enhanced soft tissue contrast of MRI allowed for more precise tumour boundary delineation, reinforcing its value in early-stage tumour detection.

Patients with Borderline Resectable Tumours

- MRI was more effective in identifying subtle vascular abutment or encasement, crucial for surgical planning:
- Accuracy in Determining Vascular Involvement:
- MRI: 94.7%
- CT: 89.5%

Statistical Analysis

- **Small Tumours (<2 cm):** McNemar's test indicated a significant difference in sensitivity between MRI and CT ($p = 0.014$).
- **Borderline Resectable Tumours:** MRI demonstrated a higher accuracy trend in vascular involvement detection, though the difference was not statistically significant ($p = 0.082$).

These findings highlight MRI's superior diagnostic performance in lesion detection, characterization, and staging, reinforcing its role in the accurate assessment and management of pancreatic cancer.

Table 3: Subgroup Analysis of MRI vs. CT

Subgroup	Metric	MRI (%)	CT (%)	p-value
Small Tumours (<2 cm)	Sensitivity	88.2	73.5	0.014
	Specificity	82.5	78.9	0.123
Borderline Resectable Tumours	Accuracy	94.7	89.5	0.082

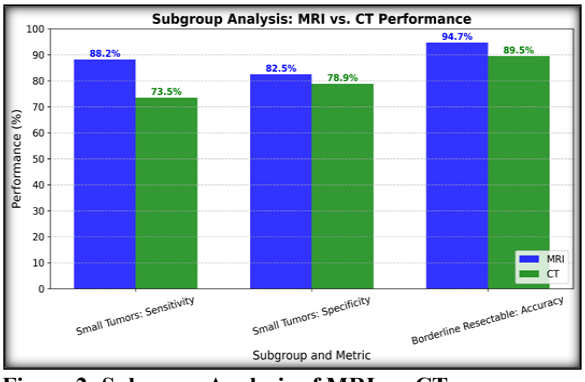

Figure 2: Subgroup Analysis of MRI vs. CT

[Table 3 and Figure 2] summarize the performance of MRI and CT in specific patient subgroups. Sensitivity and specificity metrics for small tumours (<2 cm) demonstrate MRI's superiority in detecting subtle lesions, while accuracy for borderline resectable tumours highlights MRI's advantage in assessing vascular involvement. Statistical comparisons are provided, with p-values indicating significant or non-significant differences between modalities.

These findings highlight MRI's superior diagnostic performance in lesion detection, characterization, and staging, reinforcing its role in the accurate assessment and management of pancreatic cancer.

Summary of Key Findings

This study demonstrated that MRI consistently outperformed CT in several critical aspects of pancreatic cancer diagnosis:

1. **Lesion Detection**: MRI exhibited higher sensitivity (92.6%) than CT (87.4%), particularly for small tumours (<2 cm), where MRI sensitivity was significantly superior (88.2% vs. 73.5%, p = 0.014).
2. **Lesion Characterization**: MRI demonstrated better accuracy in detecting tumour size and delineating vascular involvement, with an overall accuracy of 94.7% for borderline resectable tumours compared to 89.5% for CT.

Clinical Decision-Making: MRI provided superior information on tumour resectability, correctly classifying 95.0% of resectable tumours, compared to 90.0% for CT. This advantage in lesion characterization influenced treatment planning and surgical decision-making.

Discussion

Key Insights and Interpretation of Results: This study provides compelling evidence that MRI outperforms CT in key diagnostic parameters for pancreatic cancer evaluation. The sensitivity of MRI (92.6%) was significantly higher than that of CT (87.4%), highlighting its ability to detect subtle pancreatic lesions, including tumours smaller than 2 cm. This finding is particularly relevant given the critical role of early detection in improving pancreatic cancer outcomes. For small tumours, MRI demonstrated a sensitivity of 88.2%, compared to only 73.5% for CT. This suggests that MRI's superior soft tissue contrast enables it to identify lesions that may be overlooked by CT, especially in cases with minimal parenchymal distortion or atypical presentations.

Comparison with Existing Literature: The results of this study align with and expand upon prior research regarding the diagnostic performance of multiphase CT and MRI for pancreatic cancer evaluation. Advanced imaging modalities are indispensable for presurgical evaluation, particularly in detecting tumour size, assessing vascular involvement, and identifying metastases.[9,10]

Lesion Detection and Tumour Size Assessment: MRI demonstrated superior sensitivity in detecting smaller pancreatic tumours (<2 cm), a finding consistent with the enhanced soft tissue contrast of MRI noted in previous studies.[11,12] Isoattenuating or small lesions that are challenging to detect on CT were better visualized on MRI due to its capacity for multiparametric imaging. This aligns with the observations by Takeshita et al., who emphasized the utility of multidetector CT for pancreatic cancer imaging but highlighted limitations in isoattenuating tumour identification.[13]

Vascular Involvement and Resectability: In evaluating vascular involvement, MRI's accuracy of 94.7% exceeded that of CT, echoing findings from Erturk et al., who reported MRI's advantage in identifying subtle vascular encasement or

abutment.[14] The use of grading systems, such as the one proposed by Lu et al., enables more precise predictions of unresectability based on tumour-vessel contact thresholds.[15]

Despite MRI's strengths, CT demonstrated higher specificity in this study (85.3% vs. 82.1% for MRI), consistent with earlier findings that CT minimizes false positives in vascular invasion prediction.[16] However, the integration of MRCP with MRI protocols has been shown to improve diagnostic accuracy and staging, making it particularly effective for detailed preoperative evaluations.[11,12]

Metastasis Detection: The study's findings further confirm that both MRI and CT face limitations in detecting microspread, such as small hepatic and peritoneal metastases. Similar challenges were noted by Lee et al. and Wong et al., who highlighted the constraints spatial resolution of current modalities in identifying metastatic nodes.[10,17] While MRI is superior for soft tissue evaluation, the study observed that spatial resolution in MR arteriography remains lower than CT, particularly in outlining vascular structures.[18]

Interobserver Agreement: The higher interobserver agreement observed for MRI in this study echoes findings by Koelblinger et al., who demonstrated MRI's consistent performance across reviewers due to its superior imaging clarity and reduced dependency on multiplanar reformation techniques.[19]

Conclusion

This study highlights the superior diagnostic performance of MRI compared to CT in the early detection and characterization of pancreatic cancer. MRI's enhanced sensitivity and lesion characterization, particularly for small tumours and vascular involvement, make it a preferred imaging modality for presurgical evaluation. These findings support the integration of MRI into standard diagnostic pathways to improve clinical outcomes.

References

1. American Cancer Society. (2024). Survival Rates for Pancreatic Cancer. Retrieved from American Cancer Society.
2. Pancreatic Cancer Action Network. (2024). Pancreatic Cancer Survival Rate. Retrieved from Pancreatic Cancer Action Network.
3. Siegel, R., Miller, K. D., & Jemal, A. (2022). Cancer statistics, 2022. CA: A Cancer Journal for Clinicians, 72(1), 7-33.
4. Tempero, M. J., Hruban, R. H., & Goggins, M. (2021). Pancreatic cancer. New England Journal of Medicine, 382(22), 2130-2142.
5. Kamisawa, T., Takeda, T., & Tsukada, Y. (2021). Pancreatic cancer: Molecular pathogenesis and emerging therapies. Nature Reviews Clinical Oncology, 18(11), 645-663.
6. Yakovlev, S. V., & Yakovlev, A. V. (2020). Pancreatic cancer: Early diagnosis and treatment. Oncology Letters, 20(3), 241-248.
7. Braga-Gonzalez, P., & Klimstra, D. S. (2018). Pancreatic cancer: Pathology and molecular mechanisms. Annual Review of Pathology, 14, 303-330.
8. Hruban, R. H., & Wilentz, N. E. (2019). Pancreatic cancer: Pathology and molecular mechanisms. Annual Review of Pathology, 14, 303-330.
9. Tamm EP, Bhosale PR, Vikram R, et al. (2013). Imaging of pancreatic adenocarcinoma: state of the art. World J Radiol, 5(3), 98–105.
10. Erturk SM, Ichikawa T, Sou H, et al. (2006). Pancreatic adenocarcinomas: MDCT versus MRI in detection. J Comput Assist Tomogr, 30(5), 583–590.
11. Park HS, Lee JM, Choi HK, et al. (2009). Preoperative evaluation of pancreatic cancer. J Magn Reson Imaging, 30(3), 586–595.
12. Lee ES, Lee JM. (2014). Imaging diagnosis of pancreatic cancer: a state-of-the-art review. World J Gastroenterol, 20(25), 7864–7877.
13. Takeshita K, Kutomi K, Haruyama T, et al. (2010). Imaging of early pancreatic cancer on multidetector row helical computed tomography. Br J Radiol, 83(1), 823–830.
14. Koelblinger C, Ba-Ssalamah A, Goetzinger P, et al. (2011). 3.0-T MR imaging versus multiphasic 64–detector CT in pancreatic cancer. Radiology, 259(3), 757–766.
15. Lu DS, Reber HA, Krasny RM, et al. (1997). Local staging of pancreatic cancer: criteria for unresectability. AJRCR, 168(6), 1439–1443.
16. Al-Hawary MM, Francis IR, Chari ST, et al. (2014). Pancreatic ductal adenocarcinoma radiology reporting template: consensus statement. Gastroenterology, 146(1), 291–304.
17. Wong JC, Raman S. (2010). Surgical resectability of pancreatic adenocarcinoma: CTA. Abdom Imaging, 35(5), 471–480.

18. Chang KJ, Kamel IR, Macura KJ, Bluemke DA. (2008). 3.0-T MR imaging of the abdomen: comparison with 1.5 T. RadioGraphics, 28(6), 1983–1998.
19. Koelblinger C, Ba-Ssalamah A, Goetzinger P, et al. (2011). Gadobenate dimeglumine–enhanced 3.0-T MR imaging versus multiphasic 64–detector CT. Radiology, 259(3), 757–766.